COMPUTER AND INFORMATION NETWORKS AND SYSTEMS

MANUFACTURING AUTOMATION

КОМП'ЮТЕРНІ Й ІНФОРМАЦІЙНІ МЕРЕЖІ І СИСТЕМИ

АВТОМАТИЗАЦІЯ ВИРОБНИЦТВА

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M.V. Shevchenko, PhD, Assoc.Prof.
Kharkiv National Automobile and Highway University, 25 Petrovskogo Str., 61002 Kharkiv, Ukraine; e-mail: mshevchenko81@gmail.com

THE GENERALIZED MODEL OF ORGANIZATION AND PLANNING OF REGIONAL GAS SUPPLY MONITORING

М.В. Шевченко. **Узагальнена модель організації і планування моніторингу регіонального газопостачання**. Оскільки на даний момент газ є одним з найбільш перспективних видів палива в Україні, проблеми, пов'язані з його транспортом в системі регіонального газопостачання, є актуальними. На даний момент не вирішена до кінця і потребує докладного дослідження проблема моніторингу системи регіонального газопостачання. ***Мета:*** Метою дослідження є підвищення ефективності системи регіонального газопостачання за рахунок організації і планування моніторингу транспорту газу і, надалі, синтез системи моніторингу регіонального газопостачання. ***Матеріали і методи:*** Для досягнення мети розроблено узагальнену модель організації і планування моніторингу регіонального газопостачання, яка дозволяє приймати рішення щодо організації системи моніторингу і дає можливість отримати рекомендації для планування в умовах багатокритеріальності і невизначеності вихідних даних. ***Результати:*** Запропоновано основні критерії й обмеження для розв'язання завдання організації і планування системи моніторингу регіонального газопостачання і проведено відповідні розрахунки. Розрахунки проводилися в умовах невизначеності вихідних даних із застосуванням комплексу методів аналізу ієрархій, повного перебору варіантів, а також методів прийняття рішень в умовах невизначеності.

Ключові слова: газопостачання, трубопровід, аналіз ієрархій, мультикритеріальна оптимізація.

M.V. Shevchenko. **The generalized model of organization and planning of regional gas supply monitoring.** At the moment, gas is one of the most promising types of fuel in Ukraine. In this regard, the problems associated with its transportation in the regional system of gas supply are relevant. Now it is not completely solved and needs detailed study the problem of monitoring the regional gas supply system. ***Aim:*** The aim of the study is to improve the efficiency of the regional gas supply system at the expense of the organization and planning of gas transport monitoring and, in the future, the synthesis of the monitoring system of regional gas supply. ***Materials and Methods:*** The generalized model of organization and planning of monitoring regional gas suppliers were developed to achieve this goal. It allows making decisions on the organization of the monitoring system. In addition, this model makes it possible to plan under conditions of multicriteriality and uncertainty of the source data. ***Results:*** The basic criteria and constraints for solving the problem of organizing and planning the monitoring system of regional gas supply are proposed in this work. The corresponding computations were made to confirm the assumptions. The calculations were carried out in context of uncertainty of input data using a set of methods for the analysis of hierarchies, exhaustive search, as well as the methods of decision making in context of uncertainty.

Keywords: pipeline, gas supply, hierarchy analysis, multicriteria optimization.

Introduction. Natural and liquefied gas is one of the most promising types of fuel in Ukraine and Europe at the moment.

Using natural combustible gases is of great importance for the economic development of Ukraine. Gas is used as fuel both in industry and in everyday life. As a valuable raw material it is used in the chemical industry to produce a variety of plastics, fertilizers, synthetic fibers, rubber and other valuable materials. Furthermore, the use of gas as a fuel has a great sanitary significance. Gas burns in

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the air without smoke, soot and does not pollute the atmosphere in cities. Using gas for technological purposes of the cement, metallurgical, glass and porcelain and other industries leads to a significant increase in labour productivity and improvement of product quality. To supply the enterprises of Ukraine with natural gas, an extensive network of pipelines covering a large area and providing gas transportation within the country — a unified system of regional gas supply — is used.

Modern systems for supplying natural gas to cities, regions, small towns and industrial enterprises within the country present a single structure — a system of regional gas supply. The regional gas supply system (RGSS), which includes both the main pipeline and city networks providing consumers with gas, is a complex multi-level network constantly evolving both in space and time [1]. The structure of the SRGS is determined by a complex interrelated set of the following components: gas pipelines of different pressure, gas distribution stations (GDS), intermediate regulatory points (IRP), gas regulating points (GRP) and gas distribution plants (GDP), network equipment, systems for gas purification and odorization, systems of communication and remote operation, devices for metering natural gas consumption [1,2]. The source of supplying gas to consumers can be the main gas pipeline from natural gas fields or gas plants (when receiving synthetic gases). Gas pipelines in cities and small towns according to the gas pressure are divided into low, medium and high pressure ones [1].

At the moment, an important stage in the management, regulation and control of systems of this type is monitoring the technological processes.

However, the problems related to synthesis of monitoring systems regarding the problems of gas transportation and the use of regional gas supply systems have not been solved completely.

In [2] the justification for locations of the enterprises in the regional system of gas supply in the structure of national economy of Ukraine is presented, features of functioning are defined, the mission of these enterprises is formulated and the factors influencing the costs are determined. This work shows the characteristics of the gas supply enterprises on the basis of classification groups for these enterprises in the industrial structure of the national economy.

The patents [3,4] present the inventions, the first of which may be used to control the change of properties caused by aging of pipelines made of concrete, with accessible outer surface, in this respect, the process of monitoring is divided into static and dynamic. The second invention relates to diagnostic tools and can be used for integrated continuous monitoring of technical conditions of main pipelines. The methods and systems of monitoring proposed in these studies neither reflect the features peculiar for synthesizing this type of systems, nor consider characteristics of gas transportation in the regional gas supply system.

Thus, the main focus of the currently existing works is on monitoring the state of the pipeline itself in particular, and the regional gas supply system in general, as well as evaluating them in terms of the exposure to corrosive effects. However, the problems of computer-aided design and creation of information technologies for the monitoring of gas transportation are not paid proper attention.

The aim of the study is to improve the efficiency of the regional gas supply system at the expense of the organization and planning of gas transport monitoring and, in the future, the synthesis of the monitoring system of regional gas supply.

To achieve this objective at the first stage it is necessary to analyze the peculiarities of the regional gas supply system and specify the initial data to organize the system for monitoring the regional gas supply (SMRGS) at the second stage — to determine the number of tasks to be solved in the course of organization and planning of the system for monitoring the regional gas supply and to develop a model of the organization and planning of the regional gas supply monitoring.

Materials and Methods. Gas production and its transportation via gas pipelines can not exactly correspond to the gas consumption. Normally, the maximum capacity of the pipeline should provide the average annual gas demand [1].

Gas from the field to the gas pipeline is fed mainly evenly, but during the day, on weekdays, months and seasons of the year there are fluctuations of the gas flow, resulting in uneven gas consumption. According to [1] there are alternate periods of minimum and maximum gas consumption: at night — minimum consumption of gas, in the daytime — an increase of gas consumption compared to the daily average (daily unevenness); on Sundays — reduced gas consumption against the rest of the week (weekly unevenness); in the summer months — the minimum gas consumption, in the winter — the maximum consumption (seasonal unevenness).

The gas supply system is a multi-stage (hierarchical) structure having a distribution network of a particular complexity on each level of the hierarchy [1] with all levels being interconnected by gas pressure regulators (GDS, IRP, GRP), which ensure the preset mode in the low level distribution network.

According to [5], gas pipelines of systems for supplying small towns depending on the pressure of the transported gas are divided into:

— high-pressure gas pipelines of Category I;

— high-pressure gas pipelines of Category II.

Gas is transported to the local GRPs of large industrial enterprises, as well as enterprises, which technological processes require the use of high-pressure gas up to 1,2 MPa, through the high-pressure gas pipelines and GRPs and gas pipelines of medium pressure [1, 5].

Medium-pressure gas pipelines through GRPs supply gas to low-pressure pipelines as well as the pipelines of industrial and municipal enterprises.

The analysis of gas consumers according to their belonging to the hierarchy levels shows that from the distribution networks of the top levels (the first level — of high-pressure, the second — of medium pressure) gas is consumed by the largest of them (industrial enterprises, power plants, etc.). Distribution networks of low pressure (level 3) feed mainly the municipal consumer group [1].

As far as the three main levels of the gas supply system have been considered, let us analyze the definition of monitoring for a system of this type.

According to [6], monitoring is a continuous comprehensive control of the RGSS, measurement of parameters and analysis of the system performance. Therefore, the implementation of the monitoring process will present a solution of two major problems: measurement of the object (system) with some periodicity and analysis and evaluation of its functioning in real time mode using the methods of monitoring and measuring instruments.

Complementing and reviewing the issues presented in [6] in accordance with the aim set in this paper, at the monitoring system organization and planning it is necessary to solve the following tasks:

1) Determining the monitoring system sections and measurement points at each of the selected sections. In this case the system of monitoring coincides with the gas pipeline sections.

2) Specifying the indicators to be measured at monitoring and the measurement units.

3) Choosing the main techniques and instruments for measuring the monitoring indicators.

4) Determining the time periods (steps) for conducting the measurements.

According to the structural model proposed in [7], the stages of the monitoring system organization and planning are preliminary. In general case, the organization stage can be defined as a process ensuring the creation of more favorable conditions for achieving the aim set in the work in a specified period of time at a minimum spend of resources.

To solve the tasks set in the work, we propose the following model of the organization and planning of the RGSS monitoring.

As the initial data we will use the following parameters:

— a set of the RGSS levels $Urv = \{Urv_E\}$, where $E = \overline{1,3}$, where 3 is the number of levels, for which the monitoring is to be carried out;

— a set of the RGSS possible sections $Uch = \{Uch_{En}\}$, where $n = \overline{1, n^E}$, where n is the section number at each of the 3 levels of the system for monitoring the regional gas supply;

— a set of possible control points $G = \{g : g = \overline{1, g^n}\}$, where g^n is the number of control points, at which the instruments for measuring the gas monitoring indicators can be mounted at each section;

— a set of possible monitoring indicators $P^G = \{p : p = \overline{1, p^g}\}$, where p^g is the number of monitoring indicators at each control point;

— a set of measurement instrument types $s = \overline{1, s^P}$, where s^p is the number of instrument types for measuring indicator p ;

— the weighting factor for s -type of measuring instrument γ_{Engps} of the RGSS E th level at section n at point g while measuring indicator p , $\gamma_{Engps} \ge 0$.

Thus, the particular criteria take the form:

— the maximum of the total amount of all the estimates obtained by the conducted measurements

$$M = \max \sum_{E=1}^{3} \sum_{n=1}^{n^E} \sum_{g=1}^{g^n} \sum_{p=1}^{p^g} \sum_{s=1}^{s^p} (\gamma_{Engps} x_{Engps} + \varepsilon_{Engps} y_{Engps}) , \tag{1}$$

where x_{Engps} is a Boolean variable, which takes on two values $\{0,1\}$, x_{Engps} =1, if at point g of the RGSS E th level at section n there conducted measurement of monitoring indicator p by measuring instrument s , x_{Engps} =0 in the opposite case;

ε_{Engps} — the weighting factor for the planned number of measurements of indicator p by measuring instrument s of the RGSS E th level at section n at point g while conducting the measurements;

y_{Engps} — the planned number of measurements of indicator p at point g of the RGSS E th level at section n by measuring instrument s ;

— the minimum integrated cost for conducting the estimation of all types of measuring instruments

$$C = \min \sum_{E=1}^{3} \sum_{n=1}^{n^E} \sum_{g=1}^{g^n} \sum_{p=1}^{p^g} \sum_{s=1}^{s^p} (c_{Engps} x_{Engps} + \overline{c}_{Engps} y_{Engps}) , \tag{2}$$

where c_{Engps} is the cost of s-type of measuring instruments of the RGSS E th level at section n at point g for measuring indicator p ;

$\overline{c}_{Engps}$ is the planned cost of a single measurement of indicator p at point g at section n of the RGSS E th level by s-type of measuring instruments;

— the maximum efficiency of conducting estimation by means of the chosen types of measuring instruments

$$R = \max \sum_{E=1}^{3} \sum_{n=1}^{n^E} \sum_{g=1}^{g^n} \sum_{p=1}^{p^g} \sum_{s=1}^{s^p} (r_{Engps} x_{Engps} + \overline{r}_{Engps} y_{Engps}) , \tag{3}$$

where r_{Engps} is efficiency of measuring estimation of indicator p at point g at section n of the RGSS E th level by s-type of measuring instruments;

$\overline{r}_{Engps}$ is the planned efficiency of a single measurement of indicator p at point g at section n of the RGSS E th level by s-type of measuring instruments;

The main restrictions are imposed on the integrated costs on monitoring, which should not exceed the specified monitoring costs, which value is set by the consumer (C^Z):

$$\sum_{E=1}^{3} \sum_{n=1}^{n^E} \sum_{g=1}^{g^n} \sum_{p=1}^{p^g} \sum_{s=1}^{s^p} (c_{Engps} x_{Engps} + \overline{c}_{Engps} y_{Engps}) \le C^Z , \tag{4}$$

Besides, an additional restriction on the minimum and maximum number of measurements can be determined:

$$\min {y_{Engps}}^{GOST} \le y_{Engps} \le \max {y_{Engps}}^{SI} , \tag{5}$$

where $y_{Engps}{}^{SI}$ is the maximum possible number of measurements of indicator p at point g while conducting the measurements at section n of the RGSS E^{th} level;

$y_{Engps}{}^{GOST}$ is the minimum number of measurements of indicator p at point g while conducting the measurements at section n of the RGSS E^{th} level in accordance with the values specified by the documentation [8, 9].

In addition, the desired variables are restricted by their positivity and integrality:

$$y_{Engps} > 0\,,\; y_{Engps} = \text{int};\;\; E = \overline{1,3}\,;\; n = \overline{1,n^E}\,;\; g = \overline{1,g^n}\,;\; p = \overline{1,p^g}\,;\; s = \overline{1,s^P}\,. \qquad (6)$$

The mathematical model (1)…(6) refers to linear discrete programming problems with integer and Boolean variables by many criteria. To solve this problem methods of multicriteria discrete optimization are used [10].

Results. Let us consider the presented optimization model on the specific example of a gasification plan for small town *N*, which is made in the CAD system SolidWorks and shown in Figure 1.

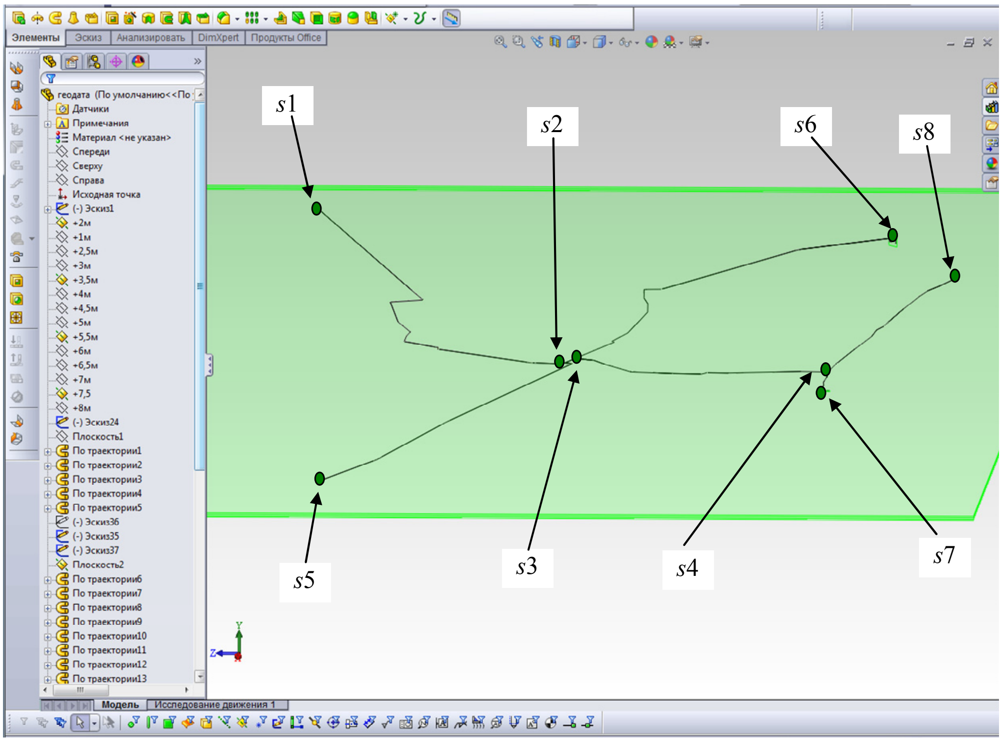

Fig. 1 The gasification plan of a small town with the selected sections

In Figure the indices from s1 to s8 mark the beginning and end points of the sections on the results of the expert evaluation.

Table 1 contains a list of sections received on the basis of the expert estimation for the monitoring system. All the sections are assigned index notations. The length of each section and additional information about the installed equipment are presented.

Relying on the proposed initial data it is possible to conduct the monitoring organization and planning. At the first stage of the organization and planning we define the set of possible control points.

On the basis of the proposed scheme of gasification and given mandatory requirement for checking the pipe connections, as well as taking into account the peculiar characteristics of the transported product — gas, it is necessary to mark the following locations of possible control points: the beginning and end of the section, the place of installation of pressure relief valves, pipe joints.

Table 1

The list of the sections and their characteristics

№	Section index	Section length, m	Additional information	Number of turns (bends), pieces	Number of pipe joints (including turns), pieces	Pressure characteristic
1	*s*1-*s*2	1328,405	Contains 1 gate valve, 12 relief valves , the point of connection to the main gas pipeline	7	19	High-pressure
2	*s*3-*s*4	391,185	Contains 4 relief valves	4	8	Low-pressure
3	*s*5-*s*6	1981,386	Contains 2 pipe plugs, 20 relief valves	2	20	Low-pressure
4	*s*7-*s*8	854,434	Contains 2 pipe plugs, 12 relief valves	–	7	Low-pressure

The above mentioned conditions can be expressed by the scheme for determining the possible points of monitoring system control (Fig. 2). The presented basic conditions should be taken into account at determining the possible locations of control points.

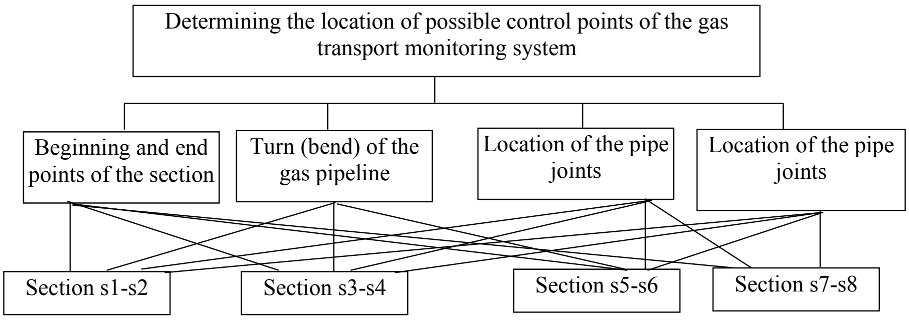

Fig. 2. The scheme of determining the possible points of control

In this case the places of pipe joints and installation of the relief valve can coincide.

Thus, the set of possible points of control on the basis of analysis of the scheme in Figure 2 will be determined by the intervals (Table 2), while assuming that the beginning of the interval suggests the minimum possible number of points — the beginning and end of the pipeline section, and the end of the interval describes the maximum number of possible control points at the section. We will consider only the sections of low pressure, because they belong to one of the above mentioned levels (the third level of the RGSS), therefore, have the same properties and characteristics of the main indicators for monitoring. Sections of high pressure may also be combined into one subgroup (the first level of the RGSS) and considered in a single aggregate. Such a combination of the sections by levels will allow to perform complex calculations for all sections at each level, and to simplify the model as follows:

$$M = \max \sum_{n=1}^{n^E} \sum_{g=1}^{g^n} \sum_{p=1}^{p^g} \sum_{s=1}^{s^p} (\gamma_{ngps} x_{ngps} + \varepsilon_{ngps} y_{ngps});$$

$$C = \min \sum_{n=1}^{n^E} \sum_{g=1}^{g^n} \sum_{p=1}^{p^g} \sum_{s=1}^{s^p} (c_{ngps} x_{ngps} + \overline{c}_{ngps} y_{ngps});$$

$$R = \max \sum_{n=1}^{n^E} \sum_{g=1}^{g^n} \sum_{p=1}^{p^g} \sum_{s=1}^{s^p} (r_{ngps} x_{ngps} + \overline{r}_{ngps} y_{ngps}).$$

Table 2

Determining the range of possible number of control points for each section

Level	№	Section index	Number of possible control points, specified by the interval	Total number of points at the level
3rd (low pressure)	2	$s3$-$s4$	2…10	6…43
	3	$s5$-$s6$	4…24	
	4	$s7$-$s8$	3…9	

In order to determine the minimum admissible set of control points on the set of possible control points, which value is specified by the interval, the method of decision-making under the interval uncertainty is used [10], as a priori information about the nature of the grouping within the interval is absent, i.e., knowledge is equally possible.

We use Hurwitz criterion of pessimism-optimism, which allows to introduce an evaluation factor called the coefficient of pessimism. The coefficient of pessimism is selected in the interval and reflects an intermediate situation between the view points of extreme optimism and extreme pessimism [10]. At the stage of the monitoring organization there takes place a rough (preliminary) evaluation of the admissible number of control points, and the value is adopted on the basis of assessment of the situation and personal experience of the experts in decision-making in similar situations. Let us assume for the calculations the value α also as an interval one and presented by the following values: $[0,4;0,6]$, where $\alpha = 0,5$ is used at equilibrium of the cost-effectiveness criteria, $\alpha = 0,4$ — at the prevalence of the weight gained by the criterion of efficiency, $\alpha = 0,6$ — provided that the criterion of cost has a greater weight. Then the result of calculating the admissible set of control points for sections of the RGSS third level is presented in Table 3.

Table 3

The admissible set of control points for each section

Level characteristic	Optimistic number of possible control points	By Hurwitz criterion*			Pessimistic number of possible control points
		$\alpha = 0,4$	$\alpha = 0,5$	$\alpha = 0,6$	
The RGSS 3rd level, low-pressure sections	6	28	25	21	43

*since the number of control points must be presented by an integer, when calculating the criteria values only the integral part of the calculated values were taken

Thus, there have been determined the intervals for the admissible set of control points at the RGSS 3rd level for all low-pressure sections. To determine the weight coefficient of indicators at the low-pressure level the method of hierarchy analysis was used [10]. The result of pairwise comparison in terms of each indicator informative value is shown in Table 4, where $k1$ — pressure, $k2$ — temperature, $k3$ — dew point of the gas moisture, $k4$ — the lowest combustion value, $k5$ — Wobbe index, $k6$ — mass concentration of hydrogen sulfide [12, 13]. The obtained conformity relation amounted to 2,6 %, which is an acceptable result (less than 10 %). The obtained conformity relation amounted to 2,6 %, which is an acceptable result (less than 10 %).

In this respect, among types of measuring instruments we'll mark the following: analogue ($f4$); digital, designed to measure one monitoring indicator ($f3$); measurement systems allowing to measure no more than 2 monitoring indicators ($f2$); measuring systems allowing to measure more than 3 or more monitoring indicators ($f1$).

For the given example of the pipeline part, let us carry out estimation of types of measuring instruments for the section of low pressure. We'll find the values using the hierarchy analysis method (Table 5) in terms of the maximum total number of all estimates of the measuring instruments.

Table 4

Estimation of monitoring indicators

	*k*1	*k*2	*k*3	*k*4	*k*5	*k*6	Component of the eigenvector	Normalized vector
*k*1	1	2	3	5	5	6	3,107233	■ 0,39527228
*k*2	1/2	1	2	3	3	4	1,817121	■ 0,23115663
*k*3	1/3	1/2	1	2	3	5	1,30766	▨ 0,16634801
*k*4	1/5	1/3	1/2	1	2	3	0,764724	0,09728091
*k*5	1/5	1/3	1/3	1/2	1	2	0,53023	0,06745081
*k*6	1/6	14	1/5	1/3	1/2	1	0,334024	0,04249135
■	— rational indicators;			▨	— admissible indicator			

Table 5

Values of the measuring instrument weight factor

	*f*1	*f*2	*f*3	*f*4	Component of the eigenvector	Normalized vector
*f*1	1	2	4	6	2,632148	0,508903
*f*2	1/2	1	2	4	1,414214	0,273426
*f*3	1/4	1/2	1	3	0,782542	0,151298
*f*4	1/6	1/4	1/3	1	0,343295	0,066373

Since at the stage of organization the exact values of the efficiency and cost are unknown, we use the particular value theory specified by fuzzy sets. Then, the result of calculating the utility value of particular cases in a fuzzified form (when the criteria values are specified by membership functions, i.e. fuzzy numbers) will look as shown in Table 6.

Table 6

Result of choosing the type of measuring instruments

	Criteria values						
Types of measuring instruments	Membership function of the cost criterion	Utility function of the cost criterion	Maximum of the total numerous estimates of measuring instruments	Utility function estimates of measuring instruments	Membership function of the efficiency criterion	Utility function of the efficiency criterion	Generalized additive utility
■ *f*1	0,3	0,25	0,5089031	1	0,9	0,88888889	0,6555555
▨ *f*2	0,5	0,5	0,2734260	0,467884	0,7	0,66666667	0,5602435
▨ *f*3	0,8	0,875	0,1512978	0,191907	0,4	0,33333333	0,5217147
*f*4	0,9	1	0,0663730	0	0,2	0,11111111	0,4444444
■	— rational type of measuring instruments;		▨	— admissible type of measuring instruments			

A particular type and kind of measuring instruments can be selected only after the stage of the monitoring system synthesis, at which the organizational structure of the monitoring system will be determined.

To determine the number of measurements for each of the indicators under conditions of information uncertainty we also use Hurwitz pessimism-optimism criterion. Since a certain number of measurements is to be carried out during a specified time period, we'll use the term "shift" (8 hours) and calculate the number of measurements per shift, then on the basis of [8,9] we obtain the data presented in Table 7.

Table 7

Admissible number of measurements[*]

Indicators	Optimistic number of measurements for each indicator per shift	By Hurwitz criterion			Pessimistic number of measurements for each indicator per shift
		$\alpha = 0,4$	$\alpha = 0,5$	$\alpha = 0,6$	
Pressure	37	28	27	24	16
Temperature	37	28	27	24	16
Dew point of gas moisture	16	10	9	7	1

[*] for the rational type of measuring instruments

As far as in Table 7 the number of control points must be presented by an integer, at calculating the criterion values the following rule was used: $\min =]y[$, $\max = [y]$, where $]y[$ and $[y]$ — correspondingly, the smallest integer, not exceeding the y value and the integer part y.

Thus, according to the results of the calculations based on the presented model, we obtain the following characteristics of the level considered (Table 8).

Table 8

The results of the monitoring organization for the third level of the RGSS

Characteristic	Characteristic description
Admissible set of control points (specified by the interval)	21…28
Admissible monitoring indicators/indices	Pressure
	Temperature
	Dew point of moisture
Admissible types of measuring instruments	Measuring systems allowing to measure more than 2 monitoring indicators
Number of measurements per shift by indicators:	
Pressure	24…28
Temperature	24…28
Dew point of moisture	7…10

The advantage of the presented generalized model is that it allows on the basis of a unified system approach to make decisions on the organization and planning of the RGSS monitoring system and makes recommendations for the monitoring system synthesis under multicriteriality and uncertainty of initial data. Operating with the volume of information on the monitoring system within the limits of 50…60 elements, at solving the generalized model it is proposed to use the method of direct and exhaustive search of possible variants. Rationality of using these methods for distributed systems is confirmed by calculations in [14].

The generalized model of organization and planning has the following specifics: at processing a large amount of information on each level of the RGSS (more than 100 components) the necessary to carry out estimation of the indicators at each of the control points will lead to a sharp increase in the time spent on decision-making. In this case, the generalized model should be decomposed into particular ones: the model of the organization of monitoring and model of planning that will be developed at further studies.

Conclusions. Thus, in the article there has been proposed the generalized model of the organization and planning of the system for monitoring the regional gas supply, which allows considering problem-solving on the basis of unified system positions under conditions of multicriteriality.

The developed generalized model of the organization and planning relates to problems of linear discrete programming and allows, unlike the existing ones, organizing the process of estimating control points, monitoring indicators, and quality of measurement instruments by many criteria.

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